698

Transistorized
Millisecond Stopclock
Type TSA3314
Instruction Manual

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NLA/BE/JP/11.63.
Issue 16

801

Transistorized Millisecond Stopclock type TSA3314

Instruction Manual

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Illustrations:	Drg. No.
Millisecond Stopclock type TSA3314 (circuit Diagram)	ES66/7
Power Supply Unit type TPC20	E66/17
Input Trigger Unit type TPC68	E66/19
MF Decade & Crystal Oscillator type TPC60/2	E66/1
Double MF Decade Unit type TPC60	E32/77
Double MF Decade Unit type TPC60/1	E32/84
Layout of TSA3314 (following page 4)	Figure 1

Transistorized Millisecond Stopclock type TSA3314

Instruction Manual.

1. Introduction:

The Venner 'TSA double-three-one-four' is a time measuring instrument having a range of 0.1mS to 99,990 seconds (approx. 27.8 hours).

Transistorized printed circuit stages are used throughout the circuit which employs a crystal controlled oscillator as reference source.

The stopclock is designed for pulse width and pulse interval measurement; for period measurement, and contact timing.

Four inline inplane digital indicators display the readout which is presented in units of milliseconds or seconds according to the range selected. The illumination and positioning of a decimal point in the display is controlled by the range selector.

A two-position Auto/Manual switch is provided; on the Auto. position, successive measurements are made automatically each readout being displayed for approximately 1.5 seconds. On the manual position, the readout is retained until a Reset pushbutton is momentarily depressed.

A positive-going signal is produced at a rear-mounted 'Carry Pulse' output socket each time the count capacity of the instrument is exceeded (i.e. each time a count of 10^4 is registered).

This signal may be used to drive external counters and display units if an extension is required in the range of the instrument.

Constructed as a compact portable unit for mains or battery operation, the TSA3314 is fitted with a specially designed carrying handle which may be rotated through 360° and used as a stand to incline the instrument at any desired angle to facilitate operation and viewing.

2. Technical Summary:

2.1. Supply.

Mains : 100/125V at 40 - 60 c/s
or 200/250V " " "

(Mains adjustment by 'tap' on transformer: See Section 5.1.)

Battery: 12V D.C.
Consumption: Mains Input : 16 Watts
Battery " : 10 Watts

2.2. Range.

0.1mS to 99,990 seconds (27.775 hours)

2.3. Accuracy.

$\pm$ Count Tolerance $\pm$ Crystal stability

Count Tolerance:-

For 1st position of Range Selector : $\pm$ 1 count

For other positions of " " : $\pm$ 0, -1count.

Crystal stability : $\pm$ 5 parts in 10^6 (15°C to 25°C).

2.4. Trigger Input (at Start & Stop terminals):

Signal : Positive or Negative pulse; Square or Sine wave.

Max. Trigger Input: Continuous rating 100V R.M.S.
Max. Impulse voltage 500V.

Min. Pulse Input: 1V peak for frequencies 200 c/s and greater. For frequencies less than 200 c/s a higher amplitude may be necessary.

Max. D.C. Input Potential: 350V.

Min. Trigger Pulse Width: 10 microseconds when triggering from leading edge of a positive or negative pulse. 0.5mS when triggering from the trailing edge of a positive or negative pulse.

Input Impedance: 35 Kilohms shunted by 150 pF.

2.5. 'Carry Pulse' Output:

Negative-going pulse (approx. -2V to -8V).

Rising-edge coincident with count of 8000.

Trailing-edge (carry signal) coincident with count of: 10000.

Output Impedance : 1 Kilohm approx.

2.6. Temperature Range:

0° to $+40^{\circ}$ Centigrade.

2.7. Dimensions & Weight (approx.)

Width	:	Height	: Depth(front to rear)	: Weight
$12\frac{3}{4}$"		$3\frac{5}{8}$"	$8\frac{5}{8}$"	$9\frac{3}{4}$lbs.
(32.5 cms)	:	(9.2 cms)	: (22 cms)	: (4.5 Kgms)

3. Transistorized Printed Circuit Stage Complement:

		Qty.
TPC6C	Double MF. Decade Unit (divider)	2
TPC60/1	Double MF. Decade Unit (counter)	2
TPC60/2	MF Decade & Crystal Oscillator Unit	1
TPC68	Input Trigger Unit	1
TPC20	Power Supply Unit	1

4. Mechanical Description:

4.1. General Construction.

The instrument is constructed as a shallow rectangular unit having recessed front and rear panels and a two sectioned wrap.

The wrap serves as a case for the instrument and comprises a large U-shaped section, which constitutes the base and sides of the unit, and a smaller inverted U-shaped section which forms a detachable lid. The lid is held in position by two screws, one at each side of the instrument.

A carrying handle, attached to each side of the large section, may be rotated through 360°; it is designed to serve as a stand, enabling the instrument to be set at various angles to facilitate operation and viewing.

4.2. Interior of Unit.

The interior of the instrument may be seen when the lid has been removed.

A bracket extending from front panel to rear panel divides the instrument into two compartments the larger of which contains the four indicator units, with their respective Set Zero and Set Nine rear-mounted controls, and the base-mounted printed circuit stages TPC68 (front) and TPC60/1 'b' (rear).

The four indicators are mechanically coupled by a bracket which extends along the backs of the units. This bracket is secured to the base of the instrument by a single screw. Removal of this 'indicator-securing-screw' and one further screw, which is situated below the display screen in the front panel, leaves the group of indicators free to be hinged upwards over the top of the front panel; this enables access to be gained to the base-mounted printed circuit stage TPC68.

Also mounted in the larger compartment are the plug-in crystal unit and preset concentric capacitor which serves as the oscillator 'trimmer'.

Principal components contained by the smaller compartment are the mains transformer (at which mains voltage settings are made); the components of the power supply circuit; the Function Selector; Range Selector; input terminals, and (in order from outer to centre of unit (the vertically-mounted printed circuit stages:-

TPC 60 'b' Ø
TPC 60 'a'
TPC 60/1 'a'
TPC 60/2
TPC 20

Ø Note: Letters in inverted commas following the stage type numbers are circuit diagram ES66/7 references.

4.3. Front Panel:

The four indicators are mounted inline on the left of the front panel and display the readout in the order, reading from left to right, most significant digit (M.S.D.) to the least significant digit (L.S.D.).

Mounted to the right of the display screen is the 7-position Function Selector switch (the extreme anti-clockwise position of which is provided as an 'OFF' position$^{\emptyset}$). To the right of this is the 6-position Range Selector, below which are the Auto/Manual switch and the pushbuttons 'Reset' and 'Reset Nine'. Below the Function Selector are the red input terminals 'Start' and 'Stop' with their black 'common' or 'earth' terminal between them.

4.4. Rear Panel:

When viewing the back of the instrument two groups of four inline slotted knobs may be seen on the right of the panel, one group above the other. These are the knobs of the Set Zero controls (upper group) and Set Nine controls (lower group) provided for adjusting the symmetry of the numeral displays.

One Set Zero and one Set Nine control is provided for each indicator. The order of control mounting in each row, reading from left to right (viewing the rear of the instrument), is:- least significant digit to most significant digit indicator-control.

$\emptyset$ Note: On Battery operation this position does not disconnect the battery supply : Refer Section 5.2.

On the left of the rear panel are fitted a 12V DC input socket, a Mains/Battery supply selector switch, the 'Carry Pulse Output' socket and a 0.5A fuse.

Two cable wrapping knobs and a cable clip are provided to facilitate stowage of the mains lead when it is not in use.

5. Operating Instructions:

5.1. Mains-voltage Setting.

Before a mains supply is applied to the instrument a check should be made to ensure that the 'tapping' selected on the internal transformer is suitable for the mains supply voltage.

Access to the transformer may be gained by removing the lid of the instrument which is held by two screws; one at each side of the unit.

The 'neutral' supply line connected to the OV tag of the transformer should not be removed. The remaining lead is provided as the moveable connection which should be soldered to the tap most appropriate for the supply. Six taps are provided:-

102 - 112 - 122 volts 205 - 225 - 245 volts.

The lid should be replaced and secured before connecting the mains supply.

5.2. Supply Connecting:

Mains: Having checked the voltage setting of the mains transformer (Section 5.1.), the Function Selector should be set to the 'OFF' position and the mains supply then connected to the 3-core mains lead as follows:-

Red Core	:	Mains 'live'
Black "	:	Mains 'neutral'
Green "	:	Earth

Battery: For battery operation the following supply-connections should be made at the 3-pin rear-mounted socket (viewing rear of instrument):-

1st pin in anti-clockwise direction from locating-inset : POSITIVE *
" " " clockwise " " " " : NEGATIVE *

The Mains/12V D.C. switch on the rear panel should be appropriately set for the type of supply being used. In the case of mains operation, clockwise rotation of the Function Selector to any one of the remaining six positions operates the mains switch and switches 'ON' the instrument ready for use. In the case of battery operation, the 12V D.C. is applied to the internal circuitry immediately the Mains/12V D.C. switch is set to the 12V D.C. position (i.e. no special battery supply switch is provided, but the Mains/12V D.C. switch may be used as a supply ON/OFF switch); current will be drawn from the supply but rotation of the Function Selector will be necessary before the instrument will operate in its various functions.

*Supply 12V D.C.

5.3. Checking Indicator Displays:

It is recommended that an initial check, and subsequent occasional checks, be made on the indicator displays.

To check the displays the instrument should be switched 'ON' and the Auto/Manual switch set to Manual.

With no signals applied at the input terminals, momentarily depress the Reset pushbutton. The figure '0' should be displayed symmetrically about the central vertical axis of each indicator frame. Where an asymmetrical display is presented by an indicator, adjustment should be made to the setting of the indicator's Set Zero control (Refer to Section 4.4. for control locations).

Having checked, and if necessary adjusted, the zero displays momentarily depress the Reset Nine pushbutton for the figure '9' to be displayed by each indicator.

The nines display should be checked for symmetry, and if necessary adjusted in a similar manner to that described for the case of the zero displays, but in this instance any adjustments for the indicators should be effected by use of the controls marked Set Nine.

After checking the all-nines display it is advisable to re-check the all-zeroes display and (if Set Zero adjustments are again made) to follow this by a re-check of the all-nines display, for the functions of the Set Zero and Set Nine controls of an indicator are to some extent inter-dependent.

5.4. Measurements and Use of Controls.

5.4.1. Principle of Instrument Operation.

With the instrument initially in the reset condition an internal 'gate' is opened when a suitable signal is applied between the Start terminal and the earth terminal.* While the gate is open, pulses derived from the internal 10 kc/s crystal controlled oscillator (and of repetition rate dependent upon the setting of the Range Selector) are fed to an electronic counter chain; the progress of the pulse-count is displayed by the four indicators.

The 'gate' is closed when a suitable signal is applied between the Stop terminal and earth terminal.*

The final pulse-count displayed by the four indicators is therefore a time measurement (in units of milliseconds, seconds or 10-seconds according to the setting of the Range Selector) of the interval between the start and stop signals.

5.4.2. Use of Function Selector ----- Types of Measurement.

The Function Selector is dual-scaled. The outer scale is associated by engraving with the Start terminal whilst the inner scale is similarly associated with the Stop terminal. The markings on the two scales serve to indicate the type of signals (applied at the Start and Stop terminals) to which the internal gating circuit responds when the respective switch positions are selected.

* Start and Stop methods for contact timing are treated in Section 5.4.2.

The different settings of the Function Selector are treated below. (Note: In each case the first symbol shown is that of the outer scale - Start input - and an initial reset condition is assumed.

For details of input signals refer to Section 2.4.).

(+ +):

On this setting the 'gate' opens when a positive-going signal (+) is applied between the Start terminal and the earth terminal, and closes when the first positive-going signal (+) is applied between the Stop terminal and earth terminal after the occurrence of a start signal. This setting may be used to time the interval between:-

(a) the leading edges of positive pulses from two separate sources.
(b) the trailing edges of negative pulses from two separate sources.

By linking together the Start and Stop terminals and applying signals, from a single source, between this link and the earth terminal the setting may be used to time the interval between:-

(c) the leading edges of two consecutive positive pulses from the same source (Period measurement).

(d) the trailing edges of two consecutive negative pulses from the same source (Period measurement).

Note: The terms 'positive pulse' and 'negative pulse' are intended to include the positive and negative excursions, respectively, of sine or square waveforms.

As a slight difference may exist between the trigger levels of the two input circuits, when operating the instrument with a single line input* and a sinusoidal waveform having a slow rise (or fall) time, it is possible for start and stop operation to occur on the leading-edge

* i.e. Start and Stop terminals linked together.

or trailing edge (according to the Function setting) of a single excursion of the input waveform. Such triggering is manifested by a time measurement less than a quarter-period of the waveform. For the same reason (possible trigger level difference) slight error can exist when operating the instrument with a two line input* and sinusoidal waveforms having slow rise (or fall) times. Here the error will be a function of the difference in trigger levels and the slopes of the respective waveforms in the trigger level region.

For the remaining switch positions marked with '+' and '-' signs, instrument operation is similar to the above, i.e. the gate is opened by a signal (of polarity shown on the outer scale) applied between the Start and earth terminals, and is closed by the first signal (of polarity shown on the inner scale) applied between the Stop and earth terminals following the occurrence of a Start signal. For measurements made in respect of signals from a single source, the method of linking the Start and Stop terminals is still applicable. On these switch positions the following measurements may be made in respect of signals from different sources or a common source:-

(+ -): On this setting the instrument measures the time between the leading edge of a +ve pulse (or trailing edge of a negative pulse) and the leading edge of a -ve pulse (or trailing edge of a positive pulse). In the case where the signals are due to one source and positive pulses are supplied, the measurement made is that of 'pulse width', whilst if negative pulses are supplied the measurement made is that of 'pulse-interval'.

* Start and Stop terminals not linked together.

(- +): On this setting the instrument measures the time between the leading edge of a -ve pulse (or trailing edge of a positive pulse) and the leading edge of a +ve pulse (or trailing edge of a negative pulse). In the case where the signals are due to one source and negative pulses are supplied, the measurement made is that of 'pulse-width', whilst if positive pulses are supplied the measurement made is that of 'pulse interval'.

(- -): On this setting the instrument measures the time between the leading edge of a -ve pulse (or trailing edge of a positive pulse) and the leading edge of a second -ve pulse (or trailing edge of a positive pulse). In the case where the signals are due to one source 'period measurement' is effected; the measurement being made between the leading edges of consecutive pulses when negative pulses are supplied, and between the trailing edges of consecutive pulses when positive pulses are supplied.

The remaining two positions of the Function Selector are intended for contact timing, the operation on the two positions being as follows:-

(S/C S/C): Timing commences when the Start terminal is short circuited to the earth terminal (the short may then be retained or removed) and ceases when the Stop terminal is short circuited to the earth terminal. This setting is suitable for measurements such as:-

(a) timing the interval between one pair of normally-open contacts closing and a second pair of normally-open contacts closing.

(b) timing the operation of changeover contacts.

N.B. Unless contact-bounce is avoided (e.g. by use of mercury switches), for this function, the 'Auto./Manual' selector should be set to 'Manual'.

(S/C O/C): Timing commences when the Start terminal is short circuited to the earth terminal and ceases:-

(i) when this short is removed,

or

(ii) when the Stop terminal is short circuited to the earth terminal.

Alternatively, if the Start and Stop terminals are initially connected to the earth terminal, timing commences when the Stop terminal is disconnected from the earth terminal and ceases:-

(i) when this connection is re-made,

or

(ii) when the Start terminal is disconnected from the earth terminal.

This setting is suitable for measuring:-

(a) the closed time of a pair of normally open contacts,

(b) the open time of a pair of normally closed contacts,

(c) the interval between the opening of two separate pairs of normally closed contacts,

(d) the time between one pair of contacts closing and another pair of contacts opening (this measurement being obtained by connecting the two pairs of contacts in series between the Start and earth terminals),

(e) the time between one pair of contacts opening and another pair of contacts closing.

N.B. Unless contact-bounce is avoided (e.g. by use of mercury switches), for this function, the 'Auto./Manual' selector should be set to 'Manual'.

Note on Trigger Operation

The Start and Stop terminals are a.c.-coupled to their internal input circuits.

Therefore, it should be noted that if a circuit of the effective form shown by Fig. 2 is to be used to deliver trigger pulses to the instrument, a 'discharge-path' comprising a resistance not greater than approximately 100kΩ should be connected between the input and earth terminals, to allow the internal coupling capacitor to discharge prior to the reception of a further trigger pulse, see Fig 3.

Fig 2

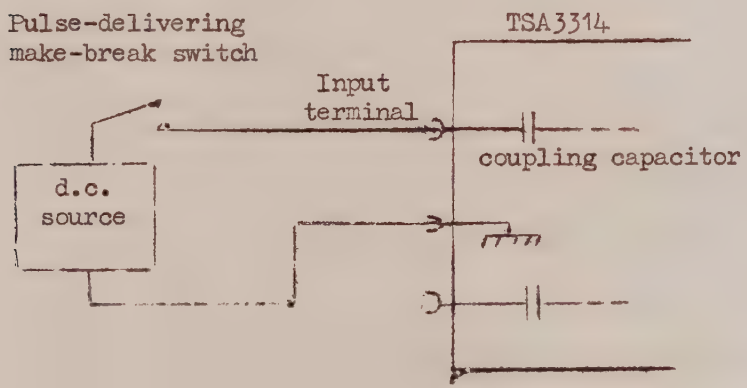
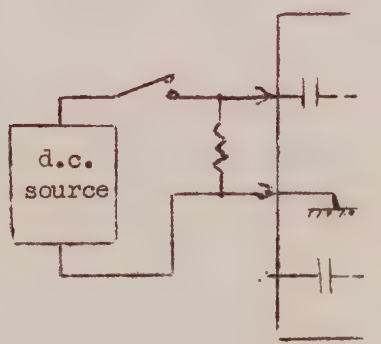


Fig 3



5.4.3. Range Selector:

The Range Selector switch has six positions; two marked 'mS', three marked 'Sec', and one marked 'Sec X10'. The display is presented in time units as indicated by the marking shown against the selected position. The different positions provided for the markings 'mS' and 'Sec' serve to control the presentation of a decimal point in the display. Below are shown the displays presented for measurements on the respective switch-positions (Note: Here the figure 0 is used to represent any integer from 0 to 9).

Switch Position	:	Display
1 (mS)	:	000.0 mS
2 "	:	0000 mS (no decimal point)
3 (Sec)	:	00.00 Sec.
4 "	:	000.0 Sec.
5 "	:	0000 Sec. (no decimal point)
6 "	:	0000 X 10 Sec. (no decimal point)

A range may be selected so that the four most significant digits (M.S.D.) of a measurement are displayed. In circumstances where the measurement can be repeated, use may then be made of lower ranges (in which the count capacity of the instrument will be exceeded) in order that digits of lesser significance than the 4th M.S.D. may be displayed.

5.4.4. Auto/Manual Switch and Reset Pushbuttons:

The setting of the Auto/Manual switch determines whether resetting of the instrument is to be automatic or by manual operation of the Reset button. On the 'Auto' setting a measurement is displayed for approximately 1.5 seconds; automatic resetting then occurs in readiness for a further measurement. On the 'Manual' setting, a measurement is displayed until the Reset button is momentarily pressed.

Depression of the Reset button results in immediate resetting, irrespective of the position to which the Auto/Manual switch is set.

The Reset Nine pushbutton is for use only in the adjustment of the indicator displays; refer to Section 5.3.

6. Maintenance:

6.1. Oscillator Trimmer.

The oscillator trimmer referred to in Section 4.2. is preset for an oscillator frequency of precisely 10 kc/s. The accuracy of the instrument is dependent upon the setting of the control, and in normal circumstances no alteration in 'trimmer' setting should be made.

However, the oscillator frequency may be monitored at the printed circuit board TPC60/2 (i.e. the vertically mounted board nearest the transformer T1). A twin-feeder may be seen connected to two soldering pins near the top of the board; the oscillator frequency

may be monitored at the pin nearest the rear of the unit. If at any time (e.g. after the instrument has given long service) frequency drift is found to have occurred, the 'trimmer' may then be adjusted for a monitored frequency of precisely 10 kc/s while comparison is made with a suitable standard frequency.

Important Note: Such adjustment necessitates operation of the instrument in the exposed condition (i.e. with the lid removed). Caution should therefore be exercised to ensure that no physical contact is made with exposed connections, particularly those in the region of the transformer, when the instrument is mains operated.

6.2. Indicator Lamp Replacement:

If an indicator lamp fails to function, note the faulty indicator, disconnect the supply and remove the lid of the instrument.

At the top-rear of each indicator a small metal strip, having a knurled knob at its centre, forms the top of the indicator-lamp housing. The strip is held by two 6 B.A. screws. On removal of these screws from the faulty indicator, the housing may be lifted out and change of lamp$^{\emptyset}$ made.

Adjustment of the new lamp to the correct position for even illumination of the display is necessary. Reconnect the supply (See Important Note in Section 6.1.) and switch 'ON' the instrument. With no external connections made at the input terminals, momentarily depress the Reset Pushbutton for an all-zeroes display.

$\emptyset$ Lamp: E.A.C. Mk11 Digivisor lamp 12V 2.2W.

With the two 6 B.A. screws of the lamp housing loose, horizontal adjustment of the lamp may be effected by movement of the housing; followed by tightening of the screws. Vertical adjustment of the lamp may be made by turning the knurled knob.

6.3. Decimal Point Lamp Replacement:

The decimal point lamp illuminated when the Range Selector is set to the 1st or 4th position (Refer: Section 5.4.3.) is housed in the least significant digit indicator, whilst that illuminated on the 3rd switch-position is housed by the 2nd least significant digit indicator.

To replace a faulty decimal point lamp, disconnect the supply and remove the lid of the unit. Withdraw the 'indicator-securing-screw' (referred to in Section 4.2.) i.e. the screw which secures the indicator bracket to the base of the instrument, and the single screw below the display screen in the front panel.

The entire indicator assembly will then be free to be hinged upwards over the top of the front panel.

Note the respective connections made at the rear and top of the faulty indicator, and then disconnect these leads. Remove the bracket which extends along the rear of the four indicators; this is secured to each indicator by one 6 B.A. screw. Finally, withdraw the two screws which hold the indicator to the bars situated above and below the display screen, and remove the indicator unit from the assembly.

Two 8 B.A. screws situated on either side of the indicator, near the front, should be extracted and the front-section (which houses the decimal point lamp) pulled away from the main-section of the indicator.

In the front-section, the decimal point lamp may then be seen located in a small hole to one side of the 'window'. Disconnect the lamp-wires from two stiff wires which are provided as supply leads. In front of the hole housing the lamp, a small lamp-retaining washer is wedged. Extract this washer from the front by use of a pointed implement such as a scriber, and push out the lamp through the front of the indicator.

A replacement lamp ø may then be inserted, and the instrument restored to an operating condition by following the above procedure effectively in reverse order.

ø Replacement lamp : E.A.C. MkII Digivisor decimal point lamp.

Note: For purposes of decimal point lamp replacement it may be found convenient to use a lamp from one of the two indicators in which the decimal point lamp is not employed.

6.4 ADJUSTMENT OF PRESET H.T. CONTROL

The voltage of the stabilized H.T. supply is determined by a preset potentiometer (RV1 on diagram E66/17) located on the Power Supply board TPC20. This board is mounted behind the 'start' terminal.

The H.T. control is set prior to despatch of the instrument, and in normal circumstances further adjustment should **not be required.** However, in the event of abnormal instrument-operation, or during servicing of the equipment, it is advisable to check the H.T, voltage and to adjust the control setting if necessary.

Important Note: For such adjustment, the instrument must be operated with the lid removed. Caution should be exercised, while the unit is operated in this condition, to ensure that no physical contact is made with exposed connections (in particular with mains connections in the region of the transformer and Function Selector switch).

There are convenient points at which the H.T. voltage may be measured on the Power Supply board. A suitable voltmeter (e.g. AVO Model 8 set to the 10V d.c. range) should be connected between the 3rd and 4th tags (top row) of the board, counting from the front panel towards the rear of the unit; the required connections are:

Positive of meter to 4th tag
Negative " " " 3rd "

The normal H.T. voltage is 8.5V: if necessary, the setting of the preset control should be adjusted to give this value.

7. Circuit Description.

7.1. Diagrams and Notation.

The circuit of the instrument is shown in block diagramatic form by drawing ES66/7. Seven circuit-blocks or stages are depicted and for these separate circuit diagrams are provided. The diagrams are listed on page (ii) of the Contents.

In Sections 7.2. to 7.10. all component references relating to the main circuit diagram (ES66/7) are under-lined (e.g. VT1); other component references relate to the diagram of the particular stage under description.

7.2. Power Supply (Drg. E66/17)

Switch SG (1 & 2) is the Mains/Battery supply selector. On mains operation (position 1) the output of transformer T1 is applied to the full-wave rectifier MR9; it also powers the lamps of digital indicators M(1-4) and for certain settings of the Range Selector, powers decimal point lamps ILP5 & 6 via SA2. On battery operation the transformer output is replaced by the battery supply applied at socket SKTC*; MR9 then serves to protect the internal circuit against incorrect connection of the battery.

The output of MR9 is stabilized by the circuit of TPC20, diagram E66/17, and VT1; the stabilized output, pre-set to -8.5V, is used as the internal H.T. supply. In the stabilizer circuit (E66/17) the reverse breakdown voltage of Zener diode MR1 serves

* Positive-line to chassis-earth.

as a voltage reference for the control of VT2. Potentiometer RV1 is the 'Pre-set H.T. Control' whose setting determines the amount of feedback applied, via VT2, to the cascade-connected stabilizers VT1 and VT1.

7.3. Start & Stop Pulse Input Circuits(E66/19)

The 'start' and 'stop' lines are respectively connected from terminals TP2 and TP1 to the rotors of Function Selector switch-wafers SC1 and SC2. This description deals with switch-settings 2 to 5, i.e. the positions for operation by pulse input.

The 'start' signal (from TP2) passes via a clipping and differentiating circuit to terminal point TP36 of the Transistorized Printed Circuit stage type TPC68 (Drg. E66/19). The signal is then passed via emitter follower VT1 and phase splitter VT2. The outputs of VT2 feed the differential amplifier formed by VT3 and VT4. The positive-going output of the differential amplifier circuit (i.e. VT4 collector output when triggering is required from positive-going input signals; VT3 collector output when triggering is required from negative-going signals) is selected by switch-wafer SC3. The signal passes via TP26 and Schmitt trigger stage VT9 & VT10. A positive-going signal occurs at the collector of VT10 and is fed via C7, as a 'start' signal, to the following gate-control 'start binary'.

A corresponding circuit to that described above exists for the 'stop' signal from TP1. For this circuit the emitter follower is VT5, phase splitter VT6 and differential amplifier VT7 and VT8. The positive-going output of the amplifier circuit is selected by switch-wafer SC4. The positive-going output

of the associated Schmitt trigger stage is produced at the collector of VT12 and is fed via C10, as a 'stop' signal, to the following gate-control 'stop binary'.

7.4. Gate Control Circuit (E66/19)

This section consists of two interlocked binary circuits and transistor stage VT18 which operates only on the 'S/C - O/C' setting of the Function Selector i.e. position 7; the latter stage is treated in Section 7.6. of this manual.

The 'start binary' contains VT13 and VT14, the 'stop binary' VT16 and VT17. In the initial reset condition transistors VT13 and VT16 conduct. The positive-going 'start pulse' produced at the junction of C7 and MR1 triggers the 'start binary'; VT14 then conducts and the binary is insensitive to further 'start signals'. As the 'start binary' is triggered, the positive-going change in VT14 collector potential is applied, via C14, to the base of VT16; this signal triggers the 'stop binary' and as VT17 conducts the potential of the gate-control-line connected to TP12 (i.e. VT18 collector) swings positive from approx.-6V to approx. -2V. For this condition of the control line the gate is held open. (Note. The gate circuit is treated in Section 7.7. of this manual).

The gate remains open until a 'stop signal' occurs at the junction of C10 and MR4; the signal triggers the 'stop binary' back to its original reset condition (i.e. VT16 conductive) whereupon the potential of the control-line swings back to approximately -6V to close the gate. Both binaries are then insensitive to further input signals until reset action occurs.

7.5. Short-circuit-start/Short-circuit-stop Operation (E66/19)

For operation by momentary or continuous short circuiting of the respective input terminals to chassis-earth (Function Selector position 6), the 'start' input terminal is connected via switch-wafer SC1 to TP14 of stage TPC68; the 'stop' terminal is connected via SC2 to TP15.

With the gate-control-binaries in the initial reset condition, a short circuit applied between the 'start' terminal and chassis-earth reduces the d.c. level at TP14 to chassis-earth potential and a positive-going 'start signal' is produced at the input of the 'start binary'; this results in opening of the gate.

When the 'stop' terminal is shorted to chassis-earth the d.c. level at TP15 is reduced to chassis-earth potential and a positive-going 'stop signal' is produced at the junction of MR4, R59; the 'stop binary' is triggered, and the gate is thus closed.

7.6. Short-circuit-start/Open-circuit-stop Operation (E66/19)

For this method of instrument operation the Function Selector is set to position 7; the interlocked binary circuit is then inoperative (due to the action of switch-wafers SC 3-5) and gate control is achieved by the function of transistor VT18.

The 'start' terminal is connected via SC1 to TP10 of stage TPC68, whilst the 'stop' terminal is connected via SC2 to TP9.

With neither input terminal connected to chassis-earth, VT18 is non-conductive and the potential of the gate-control-line (i.e. at TP12) is approx. -6V. As the 'start' terminal is shorted to chassis-earth collector current flows and the gate control potential (at TP12) swings to approx. -2V; the gate is thus opened.

The gate is closed when VT18 collector current is cut-off, i.e. when the short-circuit is removed from the 'start terminal' (or when the 'stop terminal' is shorted to chassis-earth to cause cut-off of VT18 base current).

7.7. Oscillator and Gate (E66/1)

The oscillator circuit incorporates transistors VT1 and VT2 (of stage TPC60/2) and a crystal housed by socket SKTA. The circuit is trimmed by C2 for an output signal frequency at VT2 collector of precisely 10 kc/s. The 10 kc/s signals pass to the signal input (VT3 base) of a common emitter gate formed by VT3 and VT4.

The 'gate-control-line' (TPC68 terminal point 12) is connected to the base of VT4 which serves as the control input.

When the control line potential is approximately -6V VT4 conducts and holds the gate closed, but when the line potential is approx. -2V VT4 is non-conductive and the gate is held open to allow 10 kc/s oscillator signals to pass via VT3 to the a.c.-coupled shaping circuit comprising VT5 and VT6.

The action of the shaping circuit is such that for each negative pulse occuring at the base of VT5 an approximately rectangular pulse, having a fast positive-going edge, is produced at VT6 collector.

The gated signals (available at TP32 & TP6) are passed to the input of a frequency divider chain.

7.8. Frequency Divider Chain (E66/1 & E32/77)

The frequency divider chain comprises five cascade connected decade circuits, the first of which is housed by stage TPC60/2 (Drg. E66/1) and is formed by transistors VT(9-16). The first decade operates as a divide-by-ten circuit producing one positive-going output pulse at TP5 for every ten positive-going input signals applied via C14. Each successive decade operates in a similar manner.

The 2nd & 3rd decades of the chain are housed by TPC60(a) whilst the 4th and 5th are housed by TPC60(b): both stages are represented by diagram E32/77.

The divider chain serves to supply wafer SA1 of the Range Selector with six frequencies derived from the crystal oscillator: the frequencies available at this switch-wafer are as follows:-

	Frequencies	Time Units
Switch position	1 : 10 kc/s(oscillator output)	0.1mS
" "	2 : 1 kc/s	1 "
" "	3 : 100 c/s	10 "
" "	4 : 10 c/s	100 "
" "	5 : 1 c/s	1 Sec.
" "	6 : 0.1 c/s	10 "

The setting of the Range Selector determines the frequency of signals supplied to the counter chain while the gate is held open, and therefore determines the time units in which the count is recorded.

7.9. Counter Chain & Display (E32/84 &ES66/7)

The counter chain, which is fed by signals from the rotor of SA1, comprises four identical cascade-connected decade circuits. The 1st & 2nd decades are housed by stage TPC6C/1 (a), the 3rd & 4th by TPC6C/1 (b): each stage is represented by diagram E32/84.

Within the stage type TPC60/1 (E32/84) transistors VT (1-8) constitute one decade whose output (at VT8 collector) drives a further decade formed by VT (9-16). Each decade circuit produces one positive-going output pulse for every ten positive-going signals received at its input. Staircase current outputs representative of the count states of the separate decades are produced at terminal points TP32 (1st or 3rd decade of chain) and TP6 (2nd or 4th decade). The output of the last decade is available at the 'Carry Pulse Output' socket SKTB.

Each staircase output drives a digital indicator. The four indicators M(1-4) display in units of time selected by SA1, the time for which the gate is held open. For ease of readout a decimal point is illuminated (via SA2) between M1 and M2 for settings 1 and 4 of the Function Selector, and between M2 and M3 for setting 3.

In the display circuit RV1,3,5 & 7 are the Set Zero controls and RV2,4,6 & 8 the Set Nine controls referred to in Section 5.3. of this manual.

7.10. Display Time & Reset Circuit (E66/19)

In this circuit VT19 and VT20 form a single shot multivibrator; VT21 functions as an inverter. Circuit operation depends upon the setting of the Manual/Auto switch SE but for the purpose of description the 'Auto'. setting (open condition of switch) will be assumed.

Normally VT20 conducts whilst VT19 is held cut-off. The diode matrix MR2, MR3, R64 connected to the gate-control binaries serves to produce a negative-going d.c. level change at the base of VT19 as the 'stop binary' is triggered to effect gate closure; VT19 hence conducts and VT20 is cut-off.

Owing to the charging time of C22 the multivibrator remains in this condition for approximately 3 seconds (i.e. the display period): VT20 then conducts to produce a positive-going signal at its collector. This latter signal is passed via C24 and gives rise to a negative 'reset pulse' at terminal point TP11.

The pulse is applied to both gate control binaries and sets them to the initial or reset condition; it is also fed via TP11 and used to reset to the zero condition the three stages of the frequency divider chain and both counter stages.

A reset pulse may also be initiated by momentary depression of the 'Reset Zero' push button SF. Depression of this push button disconnects the emitter of VT21 from chassis-earth and hence causes a 'reset pulse' to be produced at TP11.

With the 'Manual/Auto' switch set to 'Manual' the base of VT19 is connected to chassis-earth and the multivibrator is held inoperative. Reset action may then be initiated only by depression of push button SF.

Reset-9 Circuit.

Momentary depression of the Reset Nine push button SB gives rise to a negative pulse at the pin 1 reset nine input of each counter stage. The signal resets the counter chain to the maximum count condition (9999) required for checking the symmetry of the '9' displays (refer Section 5.3.).

8. Circuit References

8.1 Circuit Reference (ES66/7) ---------- Main Circuit

			Venner Part Number
Resistors:			
R1,3,5,7	6.8kΩ		X20635/14
R2,4,6,8	4.7kΩ		" /12
R9	3.3kΩ		" /10
R10,11	20kΩ		X20636/86
R12	150Ω		X20635/46
R13	3Ω	5W	Z21092/3
R14,15	68Ω		X20635/48
R16	1Ω		X21092/8
Resistors Variable:			
RV1,3,5,7	1kΩ	(Set Zero)	X20999/18
RV2,4,6,8	10kΩ	(Set Nine)	" /19
Capacitors:			
C1	60pF		Y20641/9
C2	4-60pF	(preset)	Z21135/2
C3,4	0.47μF		Z23914/24
C5,6	0.01μF		Y20642/16
C7 (a-c)	0.1+0.005+0.005μF		Z26102
C8	1125μF		Y20643/16
C9,10	150pF		Y20644/5
C11	8μF		Y20643/4
Diodes:			
MR1,3	BZY88/C4V7		X20639/33
MR2, (4-8)	Unused		--
MR9	M200		Z20648/9
Transistor:			
VT1	OC25		X20638/40
Transformer:			
T1	Albion: WO041		Y50049

		Vernor Part Number
Fuse:		
FS1	0.5A (H.T. fuse)	Z19831
Indicator Lamps:		
ILP 1-4	E.A.C. Mk11 Digivisor Lamps 12V 2.2W	Z27578
ILP 5,6	E.A.C. Mk11 Digivisor decimal-point lamps 6V.	-
Meter Indicators:		
M 1-4	E.A.C. Mk11 Digivisors 250μA F.S.D. (0-9)	X27086
Switches:		
SA (1-2)	Range Selector	Y50098
SB	Reset-9 push button	Z26856
SC (1-5)	Function Selector	Y50097
SE	Auto./Manual selector	Z27067
SF	Reset-0 push button	Z26856
SG (1-2)	Mains/Battery selector	Z27067
Sockets:		
SKTA	B7G holder for crystal:-	Z19839
	Marconi type QM103 (10 kc/s)	Y20650/2
SKTB	Carry Pulse output socket	X20637/85
SKTC	Battery Input. [illegible] 3-pin type TRS1	X20637/93
Terminal/Sockets:		
TP1	'Stop' terminal (red)	Z26797/1
TP2	'Start' terminal (red)	"
TP3	Chassis-earth (black)	Z26796/1

8.2 Circuit Reference (E66/17) ---------- TPC20

Resistors:		Venner Part Number
R1	1.5kΩ	X20635/7
R2	2.2kΩ	" /9
R (3-5)	1kΩ	" /6
R6	4.7kΩ	" /12
R7	680Ω	" /4
Resistor Variable:		
RV1	5kΩ	Y20640/1
Capacitors:		
C1	16μF	Y20643/25
C2,3	30μF	" /24
Diode:		
MR1	SX56	X20639/5
Transistors:		
VT1,2	OC71	X20638/1

8.3. Circuit Reference (E32/77) ----------TPC60

		Venner Part No.
Resistors:		
R1, 4, 6, 10, 13, 15, 18, 21, 23, 26, 29, 31, 35, 38, 40, 43, 46, 48, 51, 54, 56, 59, 62, 64.	10kΩ	X.20635/16
R2, 11, 19, 27, 36, 44, 52, 60.	Not used.	-
R3, 8, 12, 17, 20, 25, 28, 33, 37, 42, 45, 50, 53, 58, 61, 66.	2.2kΩ	X.20635/9
R5, 7, 30, 32, 39, 41, 63, 65.	8.2kΩ	X.20635/15
R9, 34.	27kΩ	X.20635/20
R14, 16, 22, 24, 47, 49, 55, 57.	6.8kΩ	X.20635/14
R67.	68Ω	X.20635/48
Capacitors:		
C1, 4, 7, 8, 10, 14, 17, 20, 21, 23.	220pF	Y.20641/5
C2, 3, 5, 6, 11, 15, 16, 18, 19, 24.	300pF	Y.20641/7
C9, 13, 22, 26.	390pF	Y.20641/8
C12, 25.	1000pF	Y.20641/6
Diodes:		
MR (1-20)	OA91	X.20639/12
Transistors:		
VT (1-16)	OC45	X.20635/5

3.4. Circuit Reference (T32/84)

		Venner Part Number
Resistors:		
R1,4,6,10,13,15,18,21,23,26, 29,31,35,38,40,43,46,48,51, 54,56,59,62,64	10kΩ	X20635/16
R2,36	72kΩ	X20636/29
R3,8,12,17,20,25,28,33,37,42, 45,50,53,58,61,66	2.2kΩ	X20635/9
R5,7,30,32,39,41,63,65	8.2kΩ	" /15
R9,34	27kΩ	" /20
R11,44	36kΩ	X20636/28
R14,16,22,24,47,49,55,57	6.8kΩ	X20635/14
R19,52	17.6kΩ	X20636/48
R27,60	34.75kΩ	" /49
R67	68Ω	X20635/48
Capacitors:		
C1,4,7,8,10,14,17,20,21,23	220pF	Y2064-1/5
C2,3,5,6,11,15,16,18,19,24	300pF	" /7
C9,13,22,26	390pF	" /8
C12,25	1000pF	" /6
Diodes:		
MR (1-20)	OA91	X20639/12
Transistors:		
VT (1-16)	CC45	X20638/5

8.5. Circuit Reference (E66/1) ----------TPC60/2

Resistors:		Venner Part No.
R1.	100kΩ	X.20635/27
R2.	3.3kΩ	X.20635/10
R3	56kΩ	X.20635/24
R4, 12.	4.7kΩ	X.20635/12
R5,(13-33),36,44,52,60,11	Not used.	-
R6, 39, 41, 63, 65.	8.2kΩ	X.20635/15
R7.	1.8kΩ	X.20635/8
R8.	3.9kΩ	X.20635/11
R9, 37, 42, 45, 50, 53, 58, 61, 66.	2.2kΩ	X.20635/9
R10.	100Ω	X.20635/44
R34.	27kΩ	X.20635/20
R35, 38, 40, 43, 46, 48, 51, 54, 56, 59, 62, 64.	10kΩ	X.20635/16
R47, 49, 55, 57.	6.8kΩ	X.20635/14
R67.	68Ω	X.20635/48
R68	22kΩ	X20635/19

Capacitors:

C1	0.04μF	Y20642/3
C2,4, (5-13)	Not Used	-
C3,22,26	390pF	Y2064 1/8
C14,17,20,21,23	220pF	Y20641/5
C15,16,18,19,24	300pF	Y20641/7
C25	1000pF	Y20641/6

Transistors:

VT (1-6), (9-16)	OC45	X20638/5
VT7,8	Not Used	-

Diodes:

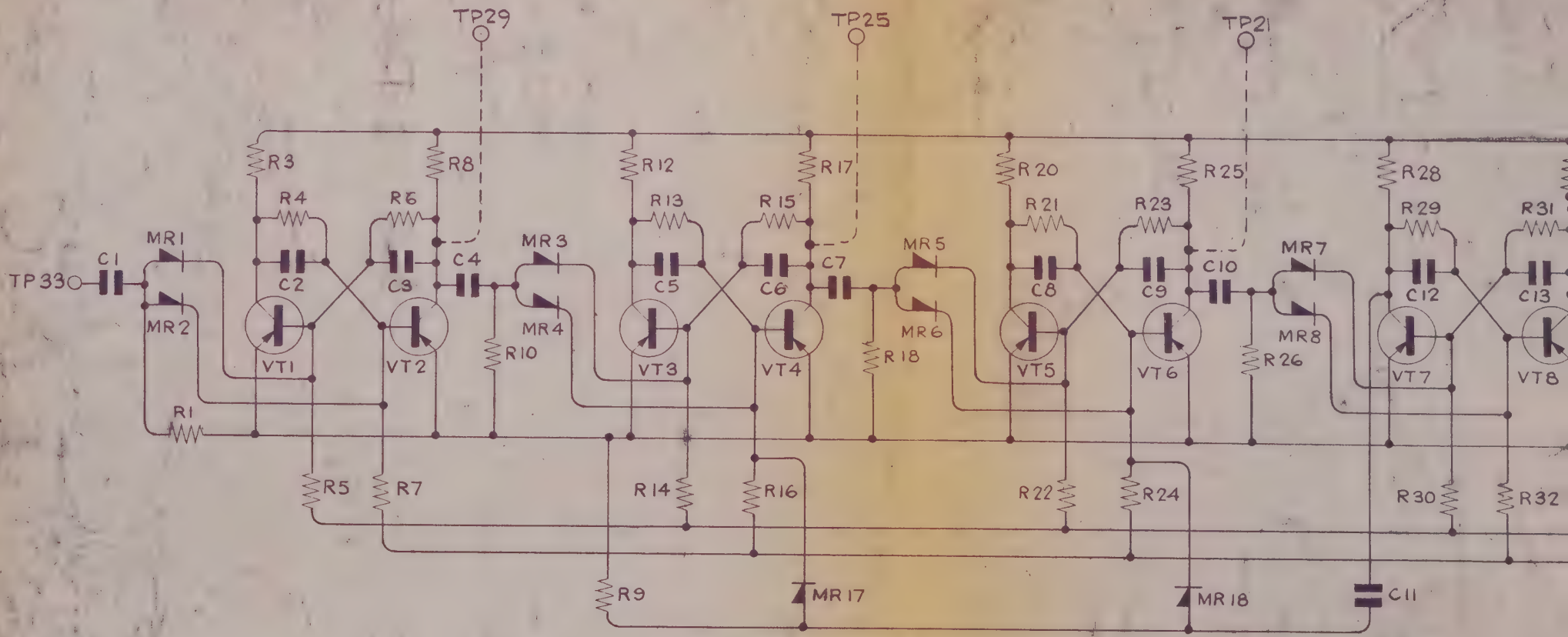
MR (1-8)	Not Used	-
MR(9-16),19,20	OA91	X20639/12

8.6. Circuit Reference (E66/19) ---------- TPC68

Resistors:		Venner Part No.
R1, 15, 30, 37.	20kΩ	X.20636/31
R2, 16.	68kΩ	X.20636/38
R3, 17.63	47kΩ	X.20635/23
R4, 5, 8, 11, 18, 19, 22, 25, 32, 39.	1kΩ	X.20636/66
R6, 13, 20, 27, 34, 41.	5.6kΩ	X.20636/67
R7, 14, 21, 28, 29.	3.3kΩ	X.20636/13
R9, 12, 23, 26.	100Ω	X.20636/1
R10, 24.	470Ω	X.20635/3
R31, 36, 38	2kΩ	X.20636/92
R33, 40.	47Ω	X.20636/41
R35, 42.	1.5kΩ	X.20636/12
R43, 45, 48, 53, 56, 58, 59, 65, 69, 73.	10kΩ	X.20635/16
R44, 49, 52, 57.	1.5kΩ	X.20635/7
R46, 47, 54, 55.	8.2kΩ	X.20635/15
R50.	220Ω	X.20635/1
R51, 74.	1kΩ	X.20635/6
R60.	56kΩ	X.20635/24
R61, 72.	3.3kΩ	X.20635/10
R62, 70, 75.	100kΩ	X.20635/27
R64.	33kΩ	X.20635/21
R66, 67.	330kΩ	X.20635/35
R68, 71.	4.7kΩ	X.20635/12

Capacitors:		
C1, 2, 3, 4, 22.	30µF	Y.20643/24
C5,8,23	8µF	Y.20643/4
C6, 7, 9, 10, 14, 18, 20.	1000pF	Y.20641/20
C11, 12, 15, 16.	300pF	Y.20641/7
C13, 25.	4µF	Y.20643/3
C17	0.01µF	Y.20642/7
C19, 21.	0.005µF	Y.20642/1
C24.	0.04µF	Y.20642/3
Transistors:		
VT1, 5.	BCZ11	X.20638/34
VT2, 6.	BSY38	X.20638/59
VT3, 4, 7, 8.	OC44	X.20638/17
VT9, 10, 11, 12.	OC42	X.20638/53
VT13, 14, (16, to 19,) 20, 21.	OC45	X.20638/5
VT15.	OC71	X.20638/1
Diodes:		
MR1, 2, 3, 4.	OC91	X.20639/12.

DRG No.	DATE	ISSUE
1007	5.12.63	A



P 889

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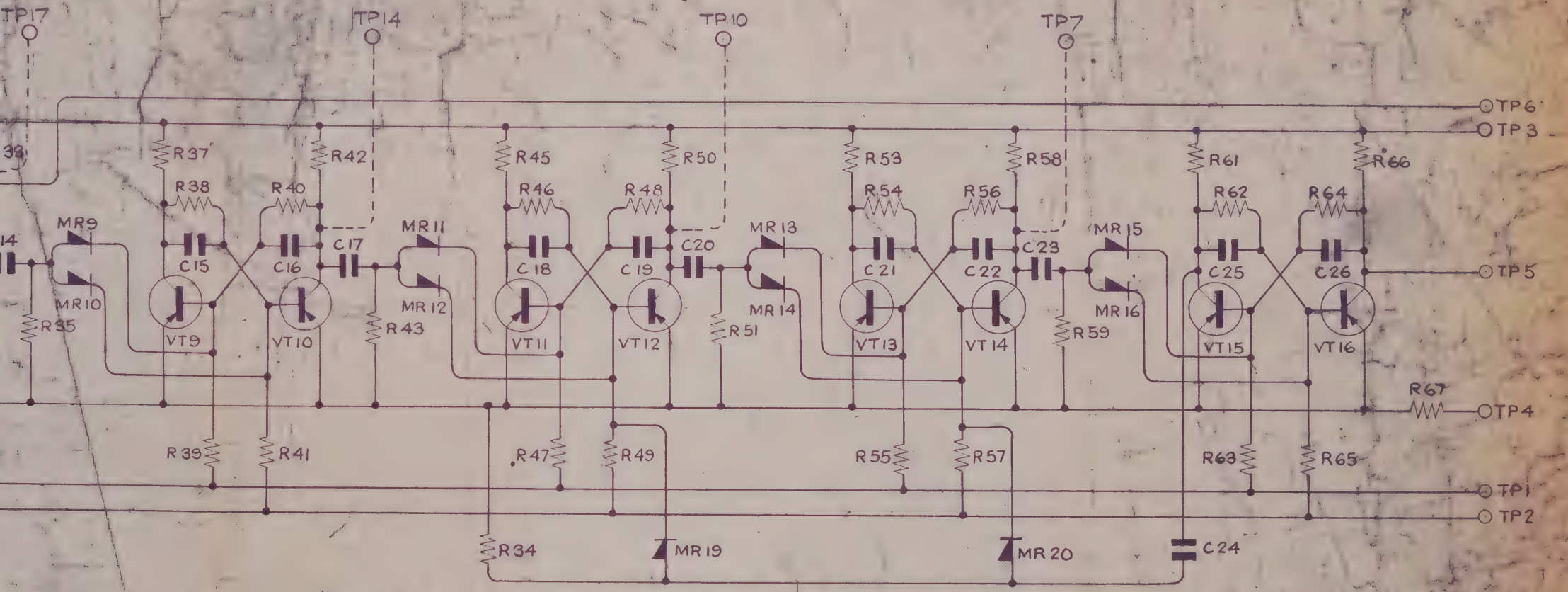

NOTE CONNECTIONS SHOWN DOTTED ARE FOR B.C.D. O/P WHEN REQUIRED.

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CHECKED	
DATE 21·12·62	

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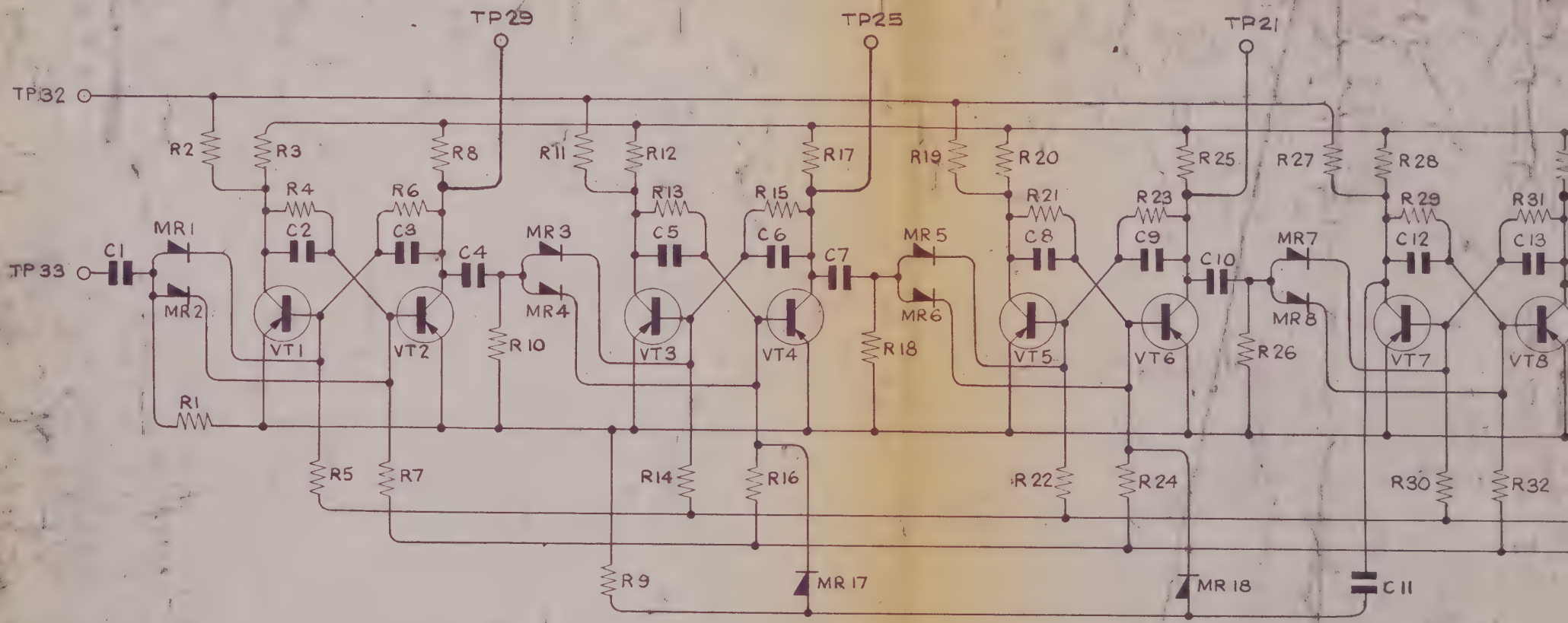

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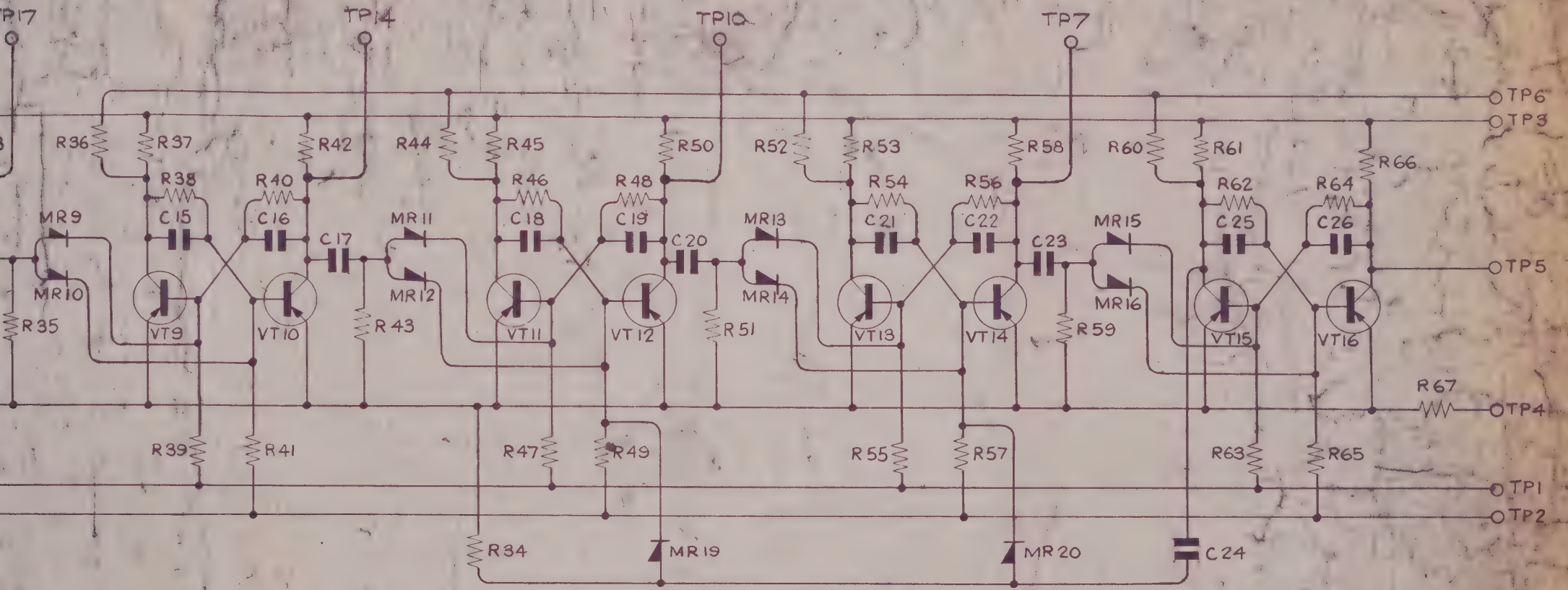
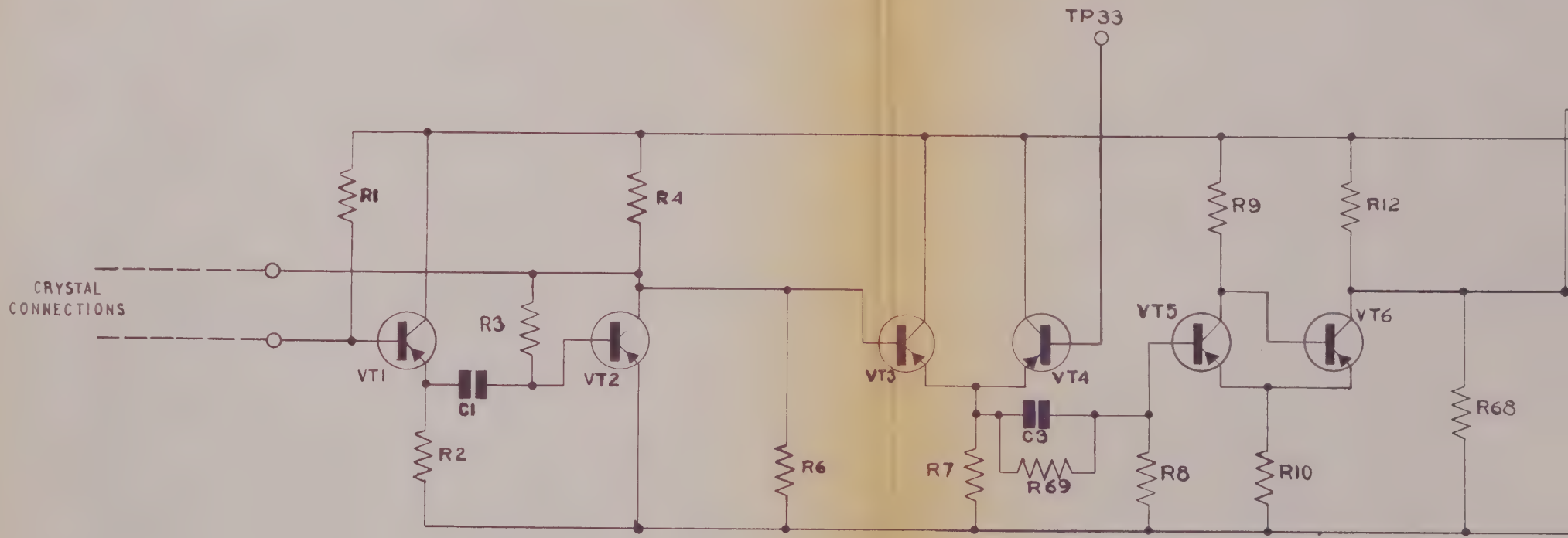


E 32/84	DOUBLE MF DECADE UNIT
DRAWN R.T.S.	TYPE TPC 60/1
CHECKED	
DATE 21·12·62	

VENNER ELECTRONICS LIMITED.
NEW MALDEN, SURREY.



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P 2008
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W50017

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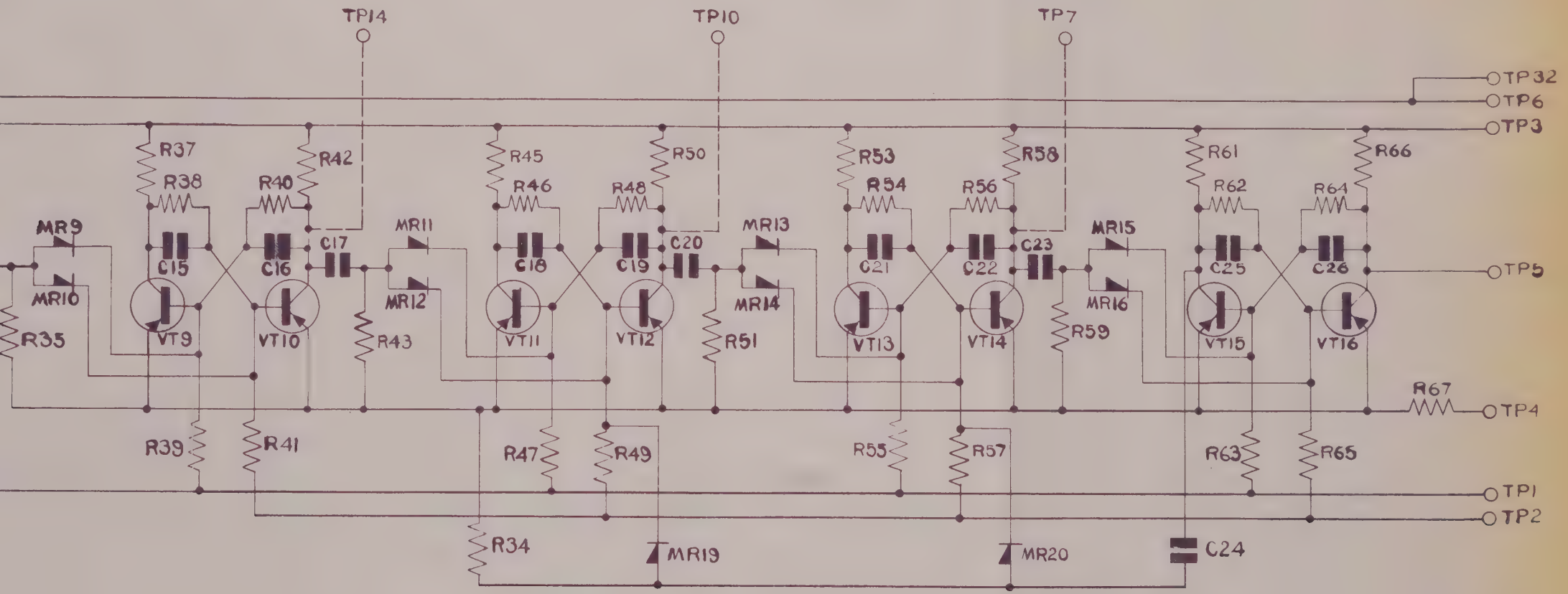
	10043	30-7-64	B
	10065	27-8-65	C
	10081		D
PASSED FOR PRODUCTION			



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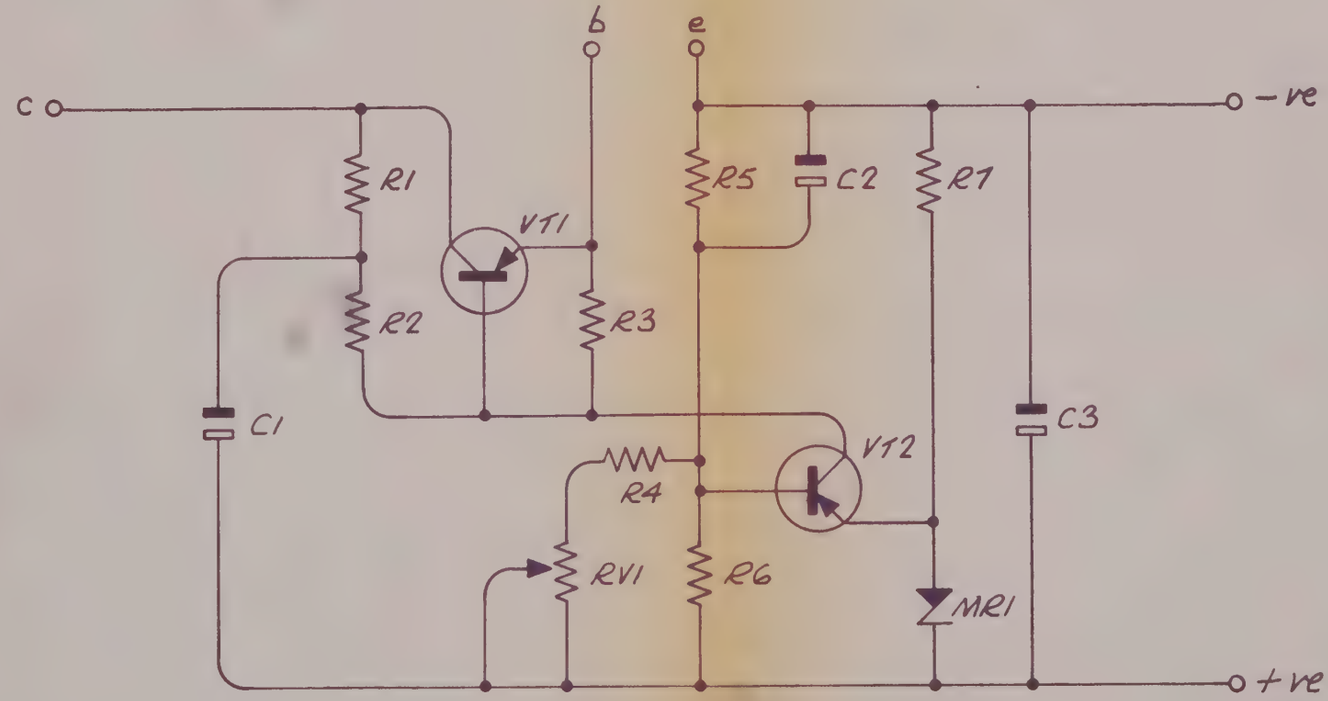
3CD O/P WHEN REQUIRED.

E 66/1		MF DECADE AND CRYSTAL OSCILLATOR TYPE TPC 60/2
DRAWN	R.T.S.	
CHECKED		
DATE	16-12-65	

VENNER ELECTRONICS LTD.

C/N No	DATE	ISS



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E66/17	
DRAWN	T.C. McCULLEY
CHECKED	
DATE	22.3.65

CIRCUIT DIAGRAM FOR POWER SUPPLY TPC20

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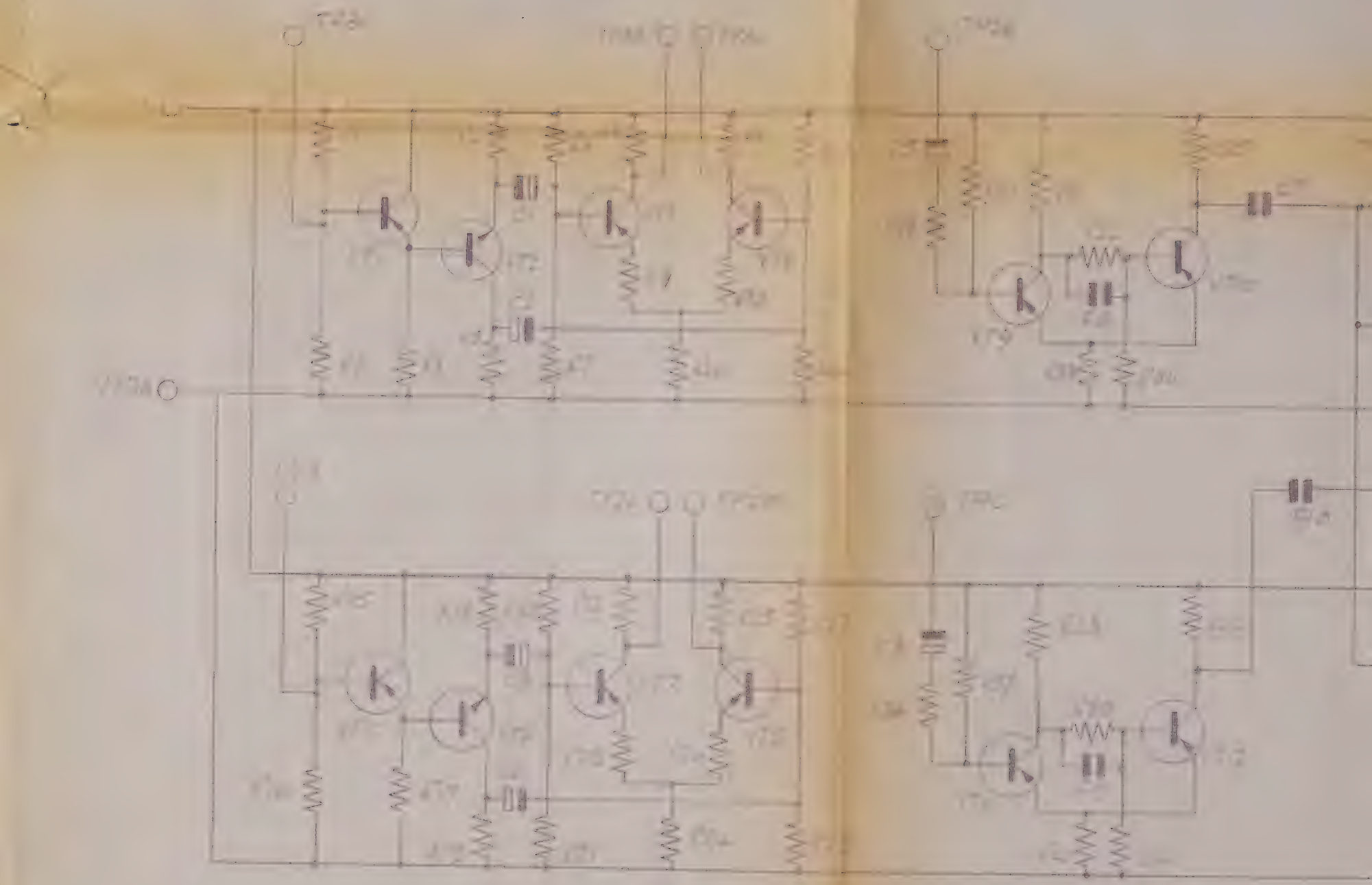
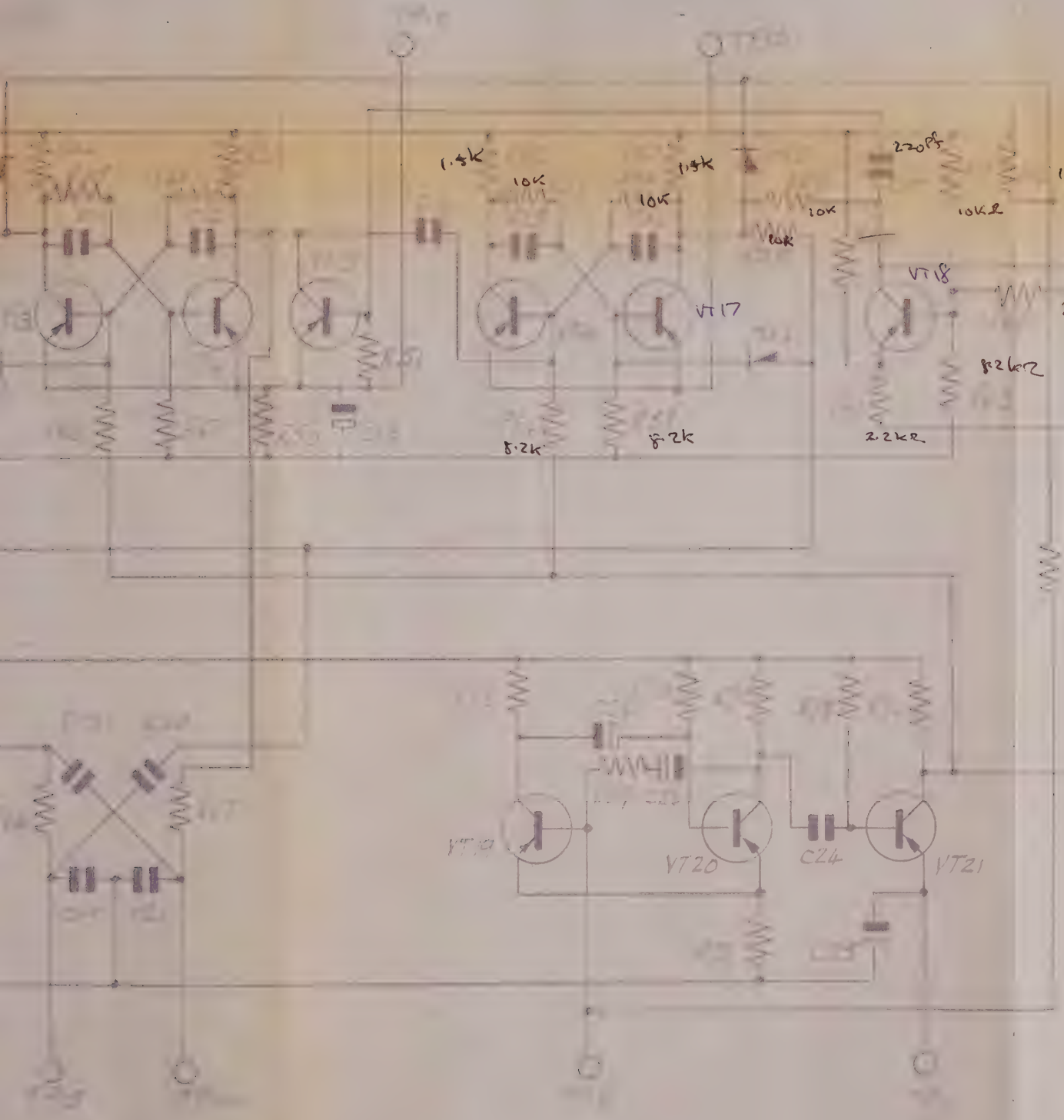
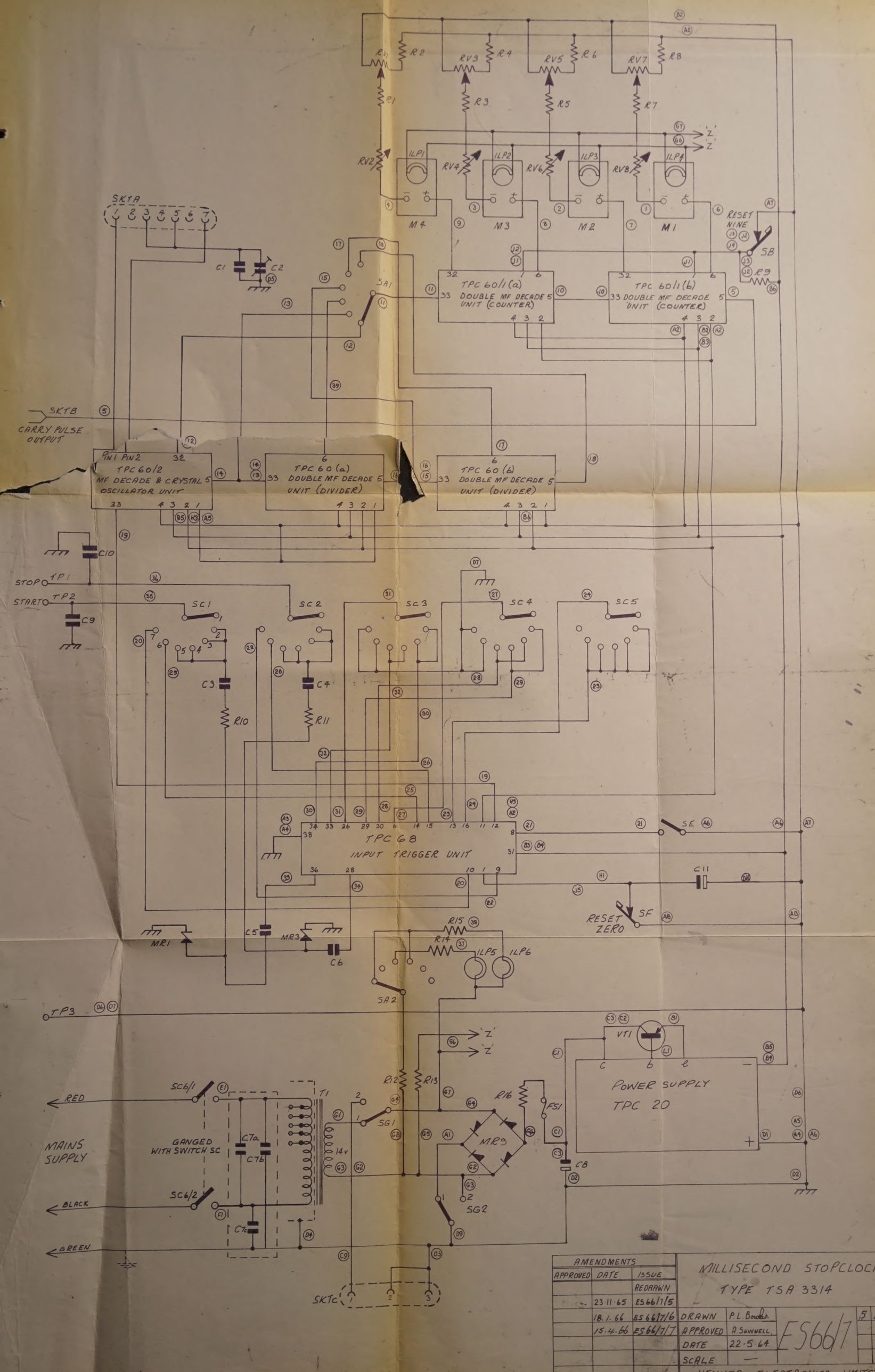




INPUT TRIGGER UNIT TPC6E



AMENDMENTS		
APPROVED	DATE	ISSUE
		REDRAWN
	23·11·65	ES66/1/5
	18.1.66	ES66/1/6
	15.4.66	ES66/1/7

MILLISECOND STOPCLOCK
TYPE TSA 3314

DRAWN	P.L. Bowden
APPROVED	A. Swinnell
DATE	22·5·64
SCALE	—

ES66/1

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